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10/511,964	10/19/2004	Masahiro Takizawa	1141/73200	8470

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COOPER & DUNHAM, LLP
1185 AVENUE OF THE AMERICAS
NEW YORK, NY 10036

EXAMINER	
SHIPMAN, JEREMIAH E	

ART UNIT	PAPER NUMBER
2859	

DATE MAILED: 01/25/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/511,964	TAKIZAWA ET AL.	
	Examiner	Art Unit	
	Jeremiah Shipman	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 October 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 October 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *1/27/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Claim 4 is objected to because of the following informalities: The claim recites the limitation "$n < m$ where the number of sensitivity image data of the plural receiving coils is n and the number of the examination data is m". The meaning of this is unclear. For instance, are n and m the number of phase encode levels, pixels, slices, bytes of data, or something else? The limitation has been interpreted to mean that the examination data is of higher resolution than the sensitivity data (perhaps in the slice direction, meaning that the examination data is composed of more slices than the sensitivity data). Clarification is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1-2, 4, and 8-16 are rejected under 35 U.S.C. 102(b) as being anticipated by Pruessmann et al. (MRM 42:952-962).

Regarding claim 1, Pruessmann et al. teach a magnetic resonance apparatus comprising a plurality of receiving coils for receiving a magnetic resonance signal generated from an object to be examined (section entitled *Sensitivity Encoding with Cartesian Sampling of k-Space*, on page 953, Par 1, line 3, "receiver array"; also the

section entitled *Phantom Experiments*, page 957, lines 1-2), sensitivity image data acquiring means for acquiring sensitivity image data by executing a first pulse sequence using the plurality of receiving coils (*Determination of Sensitivity Maps*, page 956, Par 1, lines 4-6; Par 2) from a plurality of slice positions separated from each other by intervals (*Sensitivity Maps,* page 959, Par 1), means for acquiring examination image data of each of the plural receive coils from the plural slice positions (*Sensitivity Encoding with Cartesian Sampling in k-Space*, p 953, Par 1) sequentially adjoining on the object (this is implicit in how an MRI scan is performed, one slice at a time through the volume of interest) by executing a second pulse sequence using the plural receiving coils while a phase encoding matrix in k-space is thinned out (*Sensitivity Encoding with Cartesian Sampling in k-Space*, p 953, Par 1; the phase encoding matrix is "thinned out" by Pruessmann's "reduction factor R"), and artifact removing means for generating sensitivity distribution data of the plural receiving coils on the basis of the plural sensitivity image data (*Determination of Sensitivity Maps,* p 956, par 1-2) and removing aliasing artifacts in the examination image using thus generated sensitivity distribution data of the receiving coils (*Sensitivity Encoding with Cartesian Sampling in k-Space*, p 953, Par 2).

Regarding claim 2, Pruessmann et al. further disclose the plurality of receiving coils including a receiving coil having a substantially uniform sensitivity distribution (*Determination of Sensitivity Maps,* p 956, par 2, "body coil") and a multiple receiving coil having a plurality of receiving coils (*Sensitivity Encoding with Cartesian Sampling of*

k-Space, p 953, Par 1, line 3, "receiver array"; *Phantom Experiments*, p 957, lines 1-2; *Determination of Sensitivity Maps,* p 956, par 2).

Regarding claim 4, Pruessmann teaches that the resolution of the sensitivity maps may be lower than the resolution of the image data, with the missing pixels (or slices, for reduced resolution in the slice direction) in the sensitivity maps being obtained by interpolation (*Sensitivity Maps*, p 959, Par 1).

Regarding claim 8, Pruessmann teaches the examination image data acquiring means measuring the NMR signal while thinning out every *N* steps in the phase encoding matrix of the k space of each receiving coil, where the number of receiving coils forming the multiple receiving coils is *N* (Introductory section, p 952, par 4, lines 4-13; *Sensitivity Encoding With Cartesian Sampling of k-Space*, p 953, par 4 (the paragraph beginning "Unfolding is possible..."), lines 1-4; the reduction factor (or "thinning out factor") in the imaging data acquisition of Pruessmann may have any value up to and including the number of coils).

Regarding claim 9, Pruessmann teaches sensitivity distribution data of the multiple receiving coils corresponding to the slice positions of the examination image which is not yet measured being calculated with an interpolation calculation using the measured sensitivity distribution data (*Sensitivity Maps*, p 959, Par 1).

Regarding claim 10, Pruessmann teaches the sensitivity distribution of each receiving coil of the multiple receiving coils being calculated by dividing the sensitivity image of each receiving coil by the sensitivity image obtained by the receiving coil

of k-space), and means for generating sensitivity data of each of the receiving coils on slice positions using interpolation (as discussed regarding claim 9), means for forming a determinant from the sensitivity distribution of the plural deceiving coils and the examination image data of each of the receive coils and artifact removing means for removing artifacts in the examination image by performing an inverse matrix calculation of the determinant (*Sensitivity Encoding With Cartesian Sampling of k-Space*, p 953, par 3-4; Pruessmann teaches forming a sensitivity matrix from the sensitivity data, and inverting this matrix to find the de-aliased image. Calculating the determinant is an inherent part of determining if the matrix is invertible, and of calculating the inverse. See, for instance, http://mathworld.wolfram.com/MatrixInverse.html).

Regarding claim 16, Pruessmann teaches the MRI apparatus as discussed regarding claims 1 and 15, and further teaches sensitivity distribution data acquiring means for generating sensitivity image data of a substantially uniform sensitivity distribution by combining sensitivity image data acquired by the plural receiving coils and calculating sensitivity distribution data of each receiving coil from thus combined sensitivity image data and the sensitivity image data of each receiving coil (*Determination of Sensitivity Maps*, p 956, par 2, lines 1-6, 8-13).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

having a substantially uniform sensitivity distribution (*Determination of Sensitivity Maps,* p 956, par 2, lines 1-3, 7-8).

Regarding claims 11 and 12, Pruessmann teaches that before the sensitivity distribution of each of the multiple receive coils is calculated, a processing is performed for calculating sensitivity distribution data of the receiving coil having the substantially uniform sensitivity distribution and of each receiving coil of the multiple receiving coils on the slice positions of the examination image with a slice interpolation (*Sensitivity Maps*, p 959, Par 1; Pruessman teaches that the volumetric sensitivity of the multiple receiving coils may be obtained at a low resolution, and the missing voxels (or slices, which are resolution in the slice direction) filled in by interpolation).

Regarding claim 13, Pruessmann teaches that the number of receive coils in his apparatus may be equal to two (*In Vivo Experiments*, p 957, par 1, line 1).

Regarding claim 14, Pruessmann teaches that the number of receive coils may be 3 or more (*Phantom Experiments*, p 957, par 1, line 1) and that those receiving coils are combined into a plurality of receiving coil groups, and sensitivity distribution data are combined at each receiving coil group (*Determination of Sensitivity Maps,* p 956, par 2, the data are combined in a sum-of-squares method).

Regarding claim 15, Pruessmann teaches the apparatus as discussed regarding claim 1, and further teaches the sensitivity data including an NMR signal of a low frequency region of a k-space (*Determination of Sensitivity Maps*, p 956, par 2, lines 1-3; *Sensitivity Maps,* p 959, par 1; Pruessmann's sensitivity data span the entire k-space FOV, albeit at a reduced resolution, and thus include data from the low frequency region

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Pruessmann et al. in view of King (US 6,242,916). Pruessmann et al. teaches a body coil of substantially uniform sensitivity distribution used to receive signals, as discussed above in regard to claim 2, but does not teach that this coil is also used for transmitting an RF pulse.

King teaches a modification to the SENSE technique of Pruessmann (col 2, line 66 through col 3, line 1) in which the body coil is used to transmit RF pulses (col 4, lines 43-45) and also receive them (col 4, lines 12-14). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have the body coil of Pruessmann transmit RF pulses as per King, in order to increase efficiency of design by not having two physically separate coils present when one would suffice.

6. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Pruessmann et al. in view of Damadian et al. (US 4,770,182). Pruessmann et al. do not teach the use of a multi-slice pulse sequence.

Damadian et al. teach a method for MRI in which a multi-slice pulse sequence is used (col 9, lines 29-51). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to incorporate this multi-slice pulse sequence into the method of Pruessmann et al., in order to obtain the conventional advantages of multi-slice pulse sequences, namely faster data acquisition through acquisition of several slices during a single scanning operation (Damadian, col 9, lines 29-32).

7. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Pruessmann et al. in view of Jakob et al (US 6,289,232). Pruessmann does not teach that the sensitivity image data acquiring means measures an NMR signal of each of the plural receiving coils only in a low-frequency region of the k-space having a predetermined phase encoding matrix, and the acquisition region being about one fourth the size of the phase encoding matrix.

Regarding claim 6, Jakob teaches a method for MRI parallel imaging in which coil sensitivity information is used to accelerate imaging (col 4, line 63-col 5, line 3; col 6 lines 35-44). Jakob further teaches acquiring the sensitivity information from only the central (low-frequency) region of k-space (col 6, lines 45-48; col 6 line 65 through col 7, line 2; col 14, lines 32-39; Fig 8E).

Regarding claim 7, Jakob further teaches the sensitivity data being acquired from a region of k-space of about one fourth the size of the phase encode matrix (Figure 8E, col 17, lines 45-47; col 22, lines 54-58).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the coil sensitivity information acquisition strategy of Jakob et al. in to acquire the sensitivity information of Pruessmann et al., in order to achieve the advantages sought by Jakob et al., namely speeding up the parallel imagine process (col 6, lines 6-17; 35-44).

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. King (US 2002/0171422) teaches calibrating coil sensitivity data

by measuring data on sparse slices and interpolating data for omitted slices. Takahashi et al. (Abstract of international patent application WO 01/41639, published June 14, 2001) teach determining the coil sensitivities by measuring data only in the central region of k-space.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jeremiah Shipman whose telephone number is (571)272-8439. The examiner can normally be reached on Monday-Friday, 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez can be reached on (571)272-2245. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

JS

Diego Gutierrez
Supervisory Patent Examiner
Technology Center 2800